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EVALUATION OF POLYBUTENES AS MITICIDES[1/]

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Resistance of mites to many miticides has become a matter of major concern. The problem of controlling phytophagous species in Canada by chemical means and the need for a new approach to control were cited by Fisher (4)[2/] in his initial report on the polybutenes. The United States has similar problems and needs in controlling mites on deciduous fruit trees, especially apple.

This report gives the results of biological and chemical studies of the use of polybutenes for controlling mites on apples, which were undertaken after exploratory field studies conducted in 1959 showed that these materials had a deterrent effect on the development of mite populations. This effect is due to their nondrying, highly viscous characteristics. The mites are trapped mechanically and prevented from feeding and reproducing.

The Indopol polybutenes tested are a series of butylene polymers consisting of high-molecular-weight mono-olefins (85-98 percent) and isoparaffins (Amoco Chemicals Corp. (1)). Their physical properties were as follows:

Indopol polybutene	L-10	H-35	H-100	H-300
Mean molecular weight	300	730	830	1100
Viscosity @ 100°F., SSU	114	7900	44000	140000
Viscosity @ 210°F., SSU	40.6	375	1070	3000
Viscosity, Gardner-Holt @ 77°F.	A	Z-3	> Z-6	Z-8
Specific Gravity, 60/60° F.	0.831	0.871	0.881	0.894
Refractive Index N 20°/D	1.4655	1.4860	1.4921	1.4967
Color N.P.A.	1	1	1	< 1
Pour Point (ASTM) ° F.	-65	0	20	35
Weight, lbs. U. S. gallon	6.92	7.25	7.34	7.44
Flash Point, COC, ° F.	270	295	360	480
Fire Point, COC, ° F.	280	325	425	525

1/ This research was supported in part by a cooperative agreement with the American Oil Company (Maryland).

2/ Numbers in parentheses refer to **References Cited, p. 8.**

The following formulations of the above base products were tested:

LS-0502	66.7% EC[3/] of H-300
LS-0503	55.5% EC of H-300
LS-0504	66.7% EC of H-300
LS-0504A	75% EC of H-300
LS-0510	97.3% EC of L-10
LS-0531	75% EC of H-35
LS-0564	75% EC of H-100

Laboratory Studies

Sprays were applied to lima bean plants infested with the two-spotted spider mite (Tetranychus telarius (Linnaeus)). The techniques used followed standard procedures described by Cleveland (2).

The results of tests of laboratory formulations of Indopol polybutenes H-300 and L-10, and of formulations LS-0502, LS-0503, LS-0504, and LS-0510, made in 1960, are given in table 1. The degree of control effected by all of the formulations compared favorably with that given by demeton (26.2% EC) used at the rate of 2 ounces (actual) per 100 gallons of water. The physical properties of LS-0503 were superior to those of the other formulations tested.

The results of tests of Indopol polybutene formulations LS-0503, LS-0504A, LS-0531, and LS-0564 made in 1961 are given in table 2. The efficiency of each formulation increased as the concentration of the base product was increased. Differences in effectiveness between formulations were not significant.

Field Studies

Replicated field plots containing four apple trees each were maintained in the Ferd Bolten Orchard in the spring of 1960 for the purpose of comparing control of the European red mite (Panonychus ulmi (Koch)) with different candidate insecticides and Indopol polybutene formulation LS-0503. Applications were made at the green-tip and pink-bud periods of bloom development, and at the time of early season cover sprays. No other insecticides or fungicides were included in the sprays containing LS-0503, but the grower applied the usual spray schedule that included sulfur, captan, lead arsenate, and DDT, as needed. Sprays containing LS-0503 left sticky residues on the foliage and bark for a long period after their application, but no phytotoxicity occurred. Techniques described by Cleveland (3) were used in determining the results of field tests. When the polybutene sprays were applied at the green-tip period, they were less effective than dormant oil sprays; but when they were applied at the pink-bud period, they were as effective as dormant oil applied at green tip, or chlorbenside used during the pink-bud period. Indopol polybutene applied at the time of the first cover spray was even more efficient than when applied earlier, comparing favorably with tetradifon (Tedion) (2,2,4'5-tetrachlorodiphenyl sulfone) in two post-bloom applications (table 3).

3/ Emulsifiable concentrate.

Indopol polybutene LS-0503 was included in orchard sprays applied August 4, and repeated August 25, 1960, to control high populations of the two-spotted spider mite, and moderate populations of the European red mite.

After the first application of Indopol polybutene, the mite populations were greatly reduced, and after the second application, control was excellent (table 4). An objectionable sticky residue was left on the fruit after each application. This residue was still present in September at harvest. The second application caused some foliage injury on the south side of the tree.

Counts of mite eggs made in March 1961, in the above plots, showed an average of 0.3 egg per node in the Indopol plot, and 21.1 eggs per node in an untreated plot.

The control of the European red mite with Indopol polybutene LS-0503, applied in October 1960, at the rate of 2.5 percent base product per 100 gallons of spray to replicated plots containing Red Delicious, Golden Delicious and Jonathan apple varieties was compared to the control obtained with a pink-bud application (April 18, 1961) of Indopol polybutene LS-0504A at the rate of 2 percent base product per 100 gallons, and to a check plot. The three plots received lead arsenate, 3 lbs., at petal fall, first, and second cover, and Sevin (1-naphthyl N-methylcarbamate), 1 lb., for the remainder of the season. There were no evidences of phytotoxicity to the trees, foliage, or fruit from the above treatments.

On March 28, 1961, comparison of the number of overwintered European red mite eggs on trees treated with Indopol polybutene in the fall of 1960 with the number on untreated trees, showed a substantial reduction as a result of the polybutene treatment. Both fall and spring applications held the European red mite in check through June 29, but were losing their effectiveness by July 13 (table 5).

On Oct. 14, 1960, the bark on the trunk and limbs of one tree was spot painted with Indopol polybutene H-300. The material was applied full strength with a brush to areas approximately 4 x 6 inches and, in some cases, in a band encircling limbs. An oily stain and some tackiness persisted 1 year later, but no cambium injury was noted.

Control of the European red mite on Red Delicious apple trees with Indopol polybutene LS-0504A, at 2 percent base product per 100 gallons of spray, alone and with tetradifon, 25 percent WP[4/], 1-pound formulation per 100 gallons of spray, applied at petal fall (May 1, 1961), was compared with control obtained with Sun 7 N oil, 2 percent, applied at green tip (Mar. 21, 1961), and with chlorbenside, 40 percent WP 1 lb., or tetradifon, 25 percent WP 2 lbs., applied at pink-bud stage (Apr. 24, 1961). On June 27 (57 days after petal fall) control obtained with chlorbenside, and with Indopol polybutene alone and with tetradifon was excellent; control with tetradifon alone was good. The oil application had lost its effectiveness by this time (table 8).

4/ WP = wettable powder.

Applications on May 24, 1961, of Indopol polybutenes LS-0504A, LS-0531, and LS-0564 at 2 percent actual base product per 100 gallons of spray to Grimes Golden apple trees, were very efficient in the control of European red mites for 1 month following application. Control was decreasing by July 6, and was virtually gone by July 12. There were no significant differences between formulations (table 9). No phytotoxic effects due to these treatments were noted.

Applications on July 12, 1961, of the foregoing three formulations of Indopol polybutene at dosage levels of 1 percent and 2 percent actual base product per 100 gallons of spray to Turley apple trees, gave good control of European red mites for at least 15 days following application. Spray drift from the grower's block necessitated the conclusion of the test at this early date. Again, there were no real differences between formulations or dosages (table 10). The applications on July 12 resulted in an objectionable sticky residue on the fruit that persisted through harvest. A few leaves were found with an oil-type injury, but injury was not extensive enough to establish differences between treatments. The most important injury was the formation of enlarged lenticels at the point of spray runoff. From 1 to 10 lenticels in this area were blackened and enlarged about ten times. Estimates of the extent of this injury are given below:

Plot	Percent of fruit with enlarged lenticels
Check	0
LS-0504A @ 1% base	2-5
LS-0504A @ 2% base	70-75
LS-0531 @ 1% base	70-75
LS-0531 @ 2% base	90-95
LS-0564 @ 1% base	10-15
LS-0564 @ 2% base	75-80

The formulations were more injurious at 2 percent than at 1 percent and, of the formulations, LS-0531 was the most injurious and LS-0504A was the least so.

Residues from Indopol Polybutene Sprays and the Effect of Indopol Polybutene on Other Pesticide Residues

The high viscosity and tackiness of the polybutenes suggest the possibility of a problem in residues and/or the retention of insecticides applied before, or in combination with, polybutenes. During the 1961 growing season residue analyses were made to determine the magnitude and rate of loss of polybutene sprays from apple foliage, the effect of polybutene on the magnitude of DDT residues on apple foliage, and the effect of polybutene on miscellaneous insecticide residues on apples.

Samples of foliage for residue analyses consisted of 100-leaf subsamples from each of four replicates. Fruit samples for residue analyses consisted of four 10-fruit subsamples from each of four replicates. The subsamples from each replicate were analyzed separately.

Analytical Methods:

Polybutene Analysis—The apple foliage was weighed and transferred to a 1-gallon bottle with 300 ml. of n-hexane; the bottle was sealed, and tumbled for 1 hour. The solvent was decanted and filtered, and the foliage rinsed with 100 ml. of n-hexane, and then with 50 ml. of n-hexane. The volume of solvent was adjusted to 500 ml., and 450 ml. taken for polybutene analysis.

Fruit samples were weighed and transferred to a 1-gallon bottle with 200 ml. of n-hexane; the bottle was sealed, and tumbled for 30 minutes. The solvent was decanted and filtered.

Maximum aliquots (450 ml. for foliage, and 150 ml. for fruit) were evaporated to approximately 25 ml. The sample was transferred to tared beakers and evaporated to dryness. The dry sample was heated at 105° C. for 10 minutes and weighed.

DDT Analysis—An aliquot of the sample solution obtained for polybutene analysis was analyzed by the Stiff-Castillo (8) method.

Sevin Analysis—Four 10-fruit samples were weighed and placed in 1-gallon bottles with 200 ml. of methylene dichloride. The bottles were sealed and tumbled for 10 minutes. An aliquot of this solution was analyzed for Sevin by the method of Miskus et al. (6).

Malathion Analysis—Four 10-fruit samples were weighed and placed in 1-gallon bottles with 200 ml. of carbon tetrachloride. The bottles were sealed and tumbled for 10 minutes. The residue solution was analyzed for malathion according to the method of Norris et al. (7).

Guthion (O,O-dimethyl S-(4-oxo-1,2,3-benzotriazin-3-(4H)-ylmethyl) phosphorodithioate) Analysis—Four 10-fruit samples were weighed and placed in a 1-gallon bottle with 200 ml. of benzene. The bottle was sealed, and tumbled for 10 minutes. The residue solution was analyzed for Guthion according to the method of Meagher et al. (5).

Persistence of Polybutene on Apple Foliage

A preliminary experiment was conducted in May to compare the efficacy of polybutene formulations as to deposition and persistence of residues. The polybutene formulations applied at the rate of 2 percent of base product per 100 gallons of spray were LS-0531, 75% EC, H-35; LS-0564, 75% EC, H-100; and LS-0504A, 75% EC, H-300. A single spray application was made on May 24 and samples of foliage for residue analysis collected on May 25, June 8, June 22, and July 6. On June 22, fruit was also sampled for residue analysis. The results of these analyses (table 10) show that there is little difference in the magnitude of residue deposits from LS-0531 and LS-0504A polybutene formulations. The residue from LS-0564 polybutene formulation was consistently greater than that from the other two formulations.

In a second experiment the three polybutene formulations were applied at two concentrations, 1 percent and 2 percent actual, to apple trees on July 12. Foliage samples for residue analysis were collected from these plots on July 13, 20, 28, and on August 10. The results of these analyses are given in table 11. When the concentration of Indopol polybutene was increased from 1 to 2 percent, the residue from formulations LS-0531, LS-0504A, and LS-0564 increased 46.4, 73.5, and 40.3 percent, respectively. The greatest decrease in residue deposit occurred 7 to 14 days after treatment.

The Effect of Indopol Polybutene on Residues of DDT, Guthion, Sevin, and Malathion

DDT, at the rate of 2 pounds of 50 percent wettable powder to 100 gallons, was applied in combination with 2 percent polybutenes to Grimes Golden apples on May 24. Three polybutene formulations, LS-0504A, LS-0531, and LS-0564, were employed in this test. Samples for foliage residue analysis were collected on May 25, June 8 and 22, and on July 6, and fruit residue samples were collected on June 22. The results of these analyses, table 12, show that each of the polybutenes increased the DDT residue deposit following the first cover spray. It is questionable if there was any real difference between formulations.

On July 31, 1961, plots of Red Delicious apples were treated with DDT, Guthion, Sevin, and malathion, according to the following schedules:

Plot No.	Materials per 100 Gallons of Spray
9	50% W.P. Sevin 1 lb.; 50% captan 1 lb.
20	Same as 9 plus 2% Indopol polybutene (LS-0564)
10	25% W.P. Guthion 1¼ lbs.; 50% captan 1 lb.
21	Same as 10 plus 2% Indopol polybutene (LS-0564)
11	50% W.P. DDT 2 lbs.; 50% captan 1 lb.
22	Same as 11 plus 2% Indopol polybutene (LS-0564)
19	25% W.P. malathion 2½ lbs.; 50% captan 1 lb.
23	Same as 19 plus 2% Indopol polybutene (LS-0564)

Samples of apples for analysis of residues were collected August 1, 8, 15, and 29.

The analytical results are shown in table 13. The adhesive value of the polybutene was less at this season (July 31) on Red Delicious apple trees than early in the season (May 24) on Grimes Golden apple trees (table 12). With DDT and Guthion, the polybutene had no effect on the original residue deposits. With Sevin and malathion, the original residue was decreased by the addition of polybutene. The Indopol polybutene increased the persistence of DDT and Sevin residues but had little effect on the persistence of Guthion or malathion.

Discussion and Summary of Results

Exploratory field studies in 1959 indicated that Indopol polybutene had a deterrent effect on mites and was worthy of further testing. Laboratory tests in 1960 and 1961 demonstrated that concentrations of 1 to 2.5 percent polybutene gave control of two-spotted spider mites comparable to that obtained with 0.015 percent demeton.

Field studies in 1960 with polybutene LS-0503 showed that it was less effective than dormant oil in controlling the European red mite at the green-tip period. The efficiency of the polybutene was higher when its application was delayed until the pink-bud period, at which time it was equal to a dormant oil applied during the green-tip period, or chlorbenside used during the pink-bud period. An application at the time of the first cover spray was as effective as two post-bloom applications of tetradifon. Two applications in August gave excellent control of high populations of two-spotted spider mites in combination with moderate populations of European red mite.

Experiments conducted in the field in 1961 confirmed earlier work, and demonstrated that mites can be controlled with various formulations of Indopol polybutene even when applied at different stages of tree development. There were no significant differences between formulations nor between concentrations of 1 and 2 percent.

Certain difficulties were encountered with the use of Indopol polybutene as a miticide. Applications in mid-July or later resulted in objectionable sticky residues on the fruit, which persisted to harvest. A few leaves were found with an oil-type injury following applications of LS-0504A, LS-0531, or LS-0564 to Turley apple trees on July 12, 1961, at dosage levels of 1 percent and 2 percent actual base product per 100 gallons of spray. A more important injury from these applications was the formation of enlarged lenticels at the point of spray runoff. From one to ten lenticels in this area were blackened and enlarged about ten times. The 2 percent dosage levels were more injurious than the 1 percent levels. LS-0531 was the most injurious, and LS-0504A the least injurious of the three formulations tested. Two applications of $2\frac{1}{2}$ percent LS-0503 on August 4 and 25, 1960, resulted in foliage injury and foliage drop.

Early post-bloom applications of the polybutenes were more efficient than pre-bloom applications. Treatments should be made prior to mid-June to avoid possible injury and undesirable persistent sticky residues on the fruit. Formulation LS-0504A is recommended at a concentration of 1 percent.

Studies of residue deposits resulting from early season (May 24) applications of polybutenes to apple foliage showed little difference in the magnitude of foliar residues from polybutene Nos. LS-0531 and LS-0504A. LS-0564 deposited greater residues than the other two polybutenes studied. From 55 to 59 percent of the residue deposited on May 24 was retained on the foliage 43 days later. Sprays containing 2 percent polybutene deposited from 43.5 to 73.5 percent greater residue on foliage than sprays containing 1 percent polybutene.

May 24 sprays of polybutene in combination with DDT gave greater DDT deposits on foliage and fruit than DDT sprays without polybutene. When polybutene was applied to apples in combination with DDT, Sevin, Guthion, or malathion on July 31, the DDT deposit was increased over that obtained with DDT alone; both Sevin and malathion showed a decrease in residue deposit, as compared to the deposits from sprays that did not contain polybutene; there was no difference in residues from Guthion sprays, with or without polybutene. In no instance did the harvest residue from sprays of other insecticides in combination with polybutene approach the tolerance level.

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Table 1.—Efficiency of Indopol polybutene formulations against the two-spotted spider mite in laboratory tests, 1960

Material	Date applied	Percent base product per 100 gallons water	Percent control after--	
			3 days	7 days
Demeton	2/15/60	0.015	76.4	93.8
LS-0502		2.5	75.8	85.0
LS-0502		1.25	74.2	81.4
LS-0503		2.5	89.6	90.5
LS-0503		1.25	74.6	85.1
LS-0504		2.5	82.5	81.6
LS-0504		1.25	81.5	51.6
Demeton	2/24/60	0.015	92.5	99.0
LS-0502		2.5	95.1	99.6
LS-0502		1.25	72.7	90.6
LS-0503		2.5	97.2	99.8
LS-0503		1.25	91.0	96.7
LS-0504		2.5	98.3	99.8
LS-0504		1.25	92.5	96.7
Demeton	2/29/60	0.015	90.0	100.0
L-10 EC		2.5	97.5	92.8
L-10 EC		1.25	89.3	89.3
LS-0510		2.5	99.5	99.8
LS-0510		1.25	99.8	100.0
LS-0503		2.5	98.8	99.3
LS-0503		1.25	87.0	95.3
H-300 EC		2.5	97.8	100.0
H-300 EC		1.25	78.3	99.3

Table 2.—Efficiency of Indopol polybutene formulations against the two-spotted spider mite in laboratory tests, 1961

Material	Date applied	Percent base product per 100 gallons water	Percent control after--	
			3 days	7 days
LS-0504A	4/3/61	0.5	72.7	56.0
Do		1.0	90.7	91.1
Do		2.0	93.6	98.2
LS-0531		.5	77.1	52.4
Do		1.0	96.3	97.0
Do		2.0	99.5	98.8
LS-0564		.5	89.4	63.1
Do		1.0	95.7	94.6
Do		2.0	99.2	100.0
LS-0504A	4/10/61	.5	54.1	72.5
Do		1.0	89.4	79.7
Do		2.0	95.3	96.4
LS-0531		.5	63.5	76.1
Do		1.0	98.2	89.9
Do		2.0	98.8	100.0
LS-0564		.5	85.3	59.4
Do		1.0	98.8	71.0
Do		2.0	100.0	100.0
LS-0503		.5	89.9	65.5
Do		1.0	98.7	91.0
Do		2.0	100.0	100.0

Table 3.—Control of the European red mite, spring 1960, Linton, Ind.

Materials for 100 gallons of spray	Strength	Date of Application	Mobile mites per 100 leaves				Percent control
			May 10	May 24	June 7	June 21	June 21
Green-tip application							
Indopol LS-0503 - - - - - - - - -	2½% polybutene	4/12	5	10	85	1910	66
100 viscosity oil - - - - - - - -	2 gal.		5	0	15	530	91
Pink-bud application							
Indopol LS-0503 - - - - - - - - -	2½% polybutene	4/18	0	0	5	480	91
Chlorbenside - - - - - - - - - -	40% WP 1 lb.		5	0	0	328	94
First cover							
Indopol LS-0503 - - - - - - - - -	2½% polybutene	5/10	25	0	25	160	97
First & second covers							
Tetradifon - - - - - - - - - -	25% WP 1 lb.	5/10 & 5/24	40	65	12	270	95
No miticide - - - - - - - - - -			55	175	450	5660	--

Table 4.—Control of the European red mite and two-spotted spider mite, August 1960, Vincennes, Ind.

Miticides for 100 gallons of spray	Mites per 100 leaves								Percent reduction, 14 to 15 days after treatment	
	Before spraying		After spraying							
			5 days		8 days		15 days			
	ERM	2-spot	ERM	2-spot	ERM	2-spot	ERM	2-spot	ERM	2-spot
			One application (August 4)							
Indopol LS-0503 2½% polybutene	480	13320	20	710	0	1560	0	3920	100	71
Carbophenothion (Trithion 1/) 25% WP 1½ lb. - - - - - - -	600	5800	20	2320	0	1280	100	1960	83	66
Ethion 25% WP 1½ lb. - - - - -	480	9680	120	8920	0	8560	40	4560	92	53
No miticide - - - - - - - - -	340	10200	80	25800	560	35320	400	7080	increase	31
			7 days		14 days		21 days			
			Two applications (August 4 & 25)							
Indopol LS-0503 2½% polybutene	0	2340	0	70	0	10	0	30	--	99+
Carbophenothion (Trithion) 25% WP 1½ lb. - - - - - - -	160	2780	50	500	0	710	0	1580	100	74
Ethion 25% WP 1½ lb. - - - -	10	990	70	760	0	1720	0	3000	100	increase
No miticide - - - - - - - -	1900	1460	720	200	400	520	820	1100	--	--

1/ O, O-diethyl S-(p-chlorophenylthio) methyl phosphorodithioate.

Table 5.—Comparative effectiveness of fall and spring applications of Indopol polybutene against the European red mite, 1960-1961, Vincennes, Ind.

Material per 100 gallons of spray	Date of application	Mobile mites per 100 leaves					Percent control June 29
		May 18	June 1	June 15	June 29	July 13	
Check plots, untreated	-----	5	105	470	350	1200	--
Indopol LS-0503 2½% polybutene	Oct. 14,1960	10	10	26	56	395	84.0
	Apr. 18,1961	0	0	36	43	695	87.7

Table 6.—Reduction of overwintered European red mite eggs following use of Indopol polybutene, 1961, Vincennes, Ind.

Treatment	Variety	Average number of eggs per node
Check plot, untreated	Golden Delicious	21.6
	Red Delicious	47.4
	Jonathan	9.9
Fall application, Indopol LS-0503 2½% polybutene	Golden Delicious	1.5
	Red Delicious	8.5
	Jonathan	.7

Table 7.—Efficiency of early season applications of Indopol polybutene and oil, 1961, Mt. Carmel, Ill.

Material per 100 gallons of spray	Time of application	Mobile mites per 100 leaves			Percent control June 27
		May 31	June 13	June 27	
No miticide		215	206	849	--
LS-0504A 2% polybutene	Petal fall	0	5	18	97.9
LS-0504A 2% polybutene + tetradifon 25 WP 1 lb.	Do	0	1	5	99.4
Sun 7 N oil 2%	Green-tip	25	84	480	43.5
Chlorbenside 40 WP 1 lb.	Pink-bud	0	4	17	98.0
Tetradifon 25 WP 2 lb.	Do	0	7	76	91.0

Table 8.—Effect of formulation on control of the European red mite with an early post-bloom application of two-percent polybutene, 1961, Linton, Ind.

Formulation[1/]	Mobile mites per 100 leaves				Percent control July 12
	June 8	June 22	July 6	July 12	
Check - no miticide	790	2110	2440	17400	--
LS-0504A	5	12	335	3120	82.1
LS-0531	20	0	235	1920	89.0
LS-0564	10	6	270	2000	88.5

1/ DDT (50% WP) 2 lbs. and captan (50% WP) 1½ lbs., applied with Indopol treatments and to check plots. Treatments applied May 24, 1961.

Table 9.—Effect of formulation on control of the European red mite with a July application of Indopol polybutene, 1961, Linton, Ind.

Formulation and amounts polybutene per 100 gallons Applied July 12		Mobile mites per 100 leaves		Percent control July 27
		July 12	July 27[1/]	
Check - No miticide		680	1930	--
LS-0504A	1%	590	38	98.0
	2%	1000	10	99.5
LS-0531	1%	400	24	98.8
	2%	530	36	98.1
LS-0564	1%	940	94	95.1
	2%	124	12	99.4

1/ Plots discontinued because of effect of spray drift from a grower application after count of July 27.

Table 10.—Polybutene residues from a single application on May 24, 1961, Bolten Orchard, Linton, Ind.

Polybutene formulation	Mg. polybutene per gm. of leaf				
	May 25	June 8	June 22		July 6
	Foliage	Foliage	Foliage	Fruit 1/	Foliage
LS-0504A	10.3	7.6	7.0	37	5.8
LS-0531	10.4	8.4	6.9	31	6.0
LS-0564	11.8	9.1	7.3	35	7.0

1/ Residue in mmg. per sq. cm. of fruit surface.

Table 11.—Polybutene residues on apple foliage following spray applied July 12, 1961, Bolten Orchard, Linton, Ind.

Polybutene formulation	Polybutene in mg. per gm. of leaf			
	7/13	7/20	7/28	8/10
LS-0504A				
1% - - - - - - - - -	4.2	3.9	2.7	4.0
2% - - - - - - - - -	7.3	6.0	5.5	5.5
LS-0531				
1% - - - - - - - - -	4.1	2.8	1.9	2.6
2% - - - - - - - - -	6.0	4.8	4.3	4.8
LS-0564				
1% - - - - - - - - -	5.2	4.1	3.8	4.0
2% - - - - - - - - -	7.3	7.1	5.1	6.8

Table 12.—DDT residues from DDT-Polybutene spray applied May 24, 1961, Bolten Orchard, Linton, Ind.

Polybutene	Mg. DDT per gm. of leaf				
	May 25	June 8	June 22		July 6
	Foliage	Foliage	Foliage	Fruit 1/	Foliage
None	0.46	0.06	0.04	0.53	0.03
LS-0504A	.60	.38	.28	1.46	.24
LS-0531	.62	.45	.30	1.36	.26
LS-0564	.75	.51	.36	1.81	.32

1/ Residue in mmg. per sq. cm. of fruit surface.

Table 13.—Effect of Indopol polybutene (LS-0564) on residues of DDT, Sevin, malathion, and Guthion on apples, 1961, Acobert Orchard, Vincennes, Ind.

Plot No.	Treatment	Residue in p.p.m. 1/			
		Aug. 1	Aug. 8	Aug. 15	Aug. 29
11	DDT	3.6	2.3	2.1	1.2
22	DDT + Indopol	3.8	3.3	2.9	2.5
9	Sevin	2.4	0.6	0.2	0.1
20	Sevin + Indopol	1.3	.4	.2	.1
19	Malathion	1.6	0.1	--	--
23	Malathion + Indopol	.8	.1	--	--
10	Guthion	1.0	0.5	0.4	0.3
21	Guthion + Indopol	1.0	.6	.4	.2

1/ Average of four analyses.